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# Endoscopic vein harvest in elective off-pump coronary artery bypass grafting

Nai-kuan CHOU, Meng-lin LEE, Shoei-shen WANG[†‡]

(*Division of Cardiovascular Surgery, National Taiwan University Hospital, College of Medicine, National Taiwan University, Taipei City*)

[†]E-mail: wangp@ntu.edu.tw

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**Abstract:** While traditional open vein harvest was related to postoperative wound complications, endoscopic vein harvest was developed to minimize the morbidity in the greater saphenous vein harvest procedure. In this study, these two procedures were compared for postoperative wound healing and long-term graft patency. We reviewed all consecutive patients undergoing elective off-pump coronary artery bypass grafting from January 2004 to December 2005 and collected data regarding wound complications and coronary events. Wound complications included dehiscence, excessive discharge, edema, altered sensation, cellulitis, hematoma, pain scale, and superficial and deep wound infection. Coronary events were defined as diagnosis of myocardial infarction during the first year's follow-up. A total of 392 patients were included in our series, among whom 44 were excluded from the study due to emergent operation, preoperative intra-aortic balloon pump support, or the greater saphenous vein varicose characteristic, 78 belonged to open vein harvest group, and 270 to endoscopic vein harvest group. Wound complications were significantly less in the endoscopic group (5.2%) compared to the open group (19.2%) ($P$=0.0002). There was no significant difference on preoperative risk factors, total operative time, or hospitalization days. During one-year follow-up, both the early and late graft patency rates were similar between the two groups. Endoscopic vein harvest is safe and effective, which carries less risk for wound complications and is associated with better satisfaction and cosmetic result than the traditional greater saphenous vein harvest procedure. The endoscopic vein harvest also demonstrates a great long-term patency.

**Key words:** Endoscopic vein harvest (EVH), Open vein harvest (OVH), Off-pump coronary artery bypass grafting, Greater saphenous vein (GSV), Internal mammary artery (IMA)

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## INTRODUCTION

Although internal mammary arterial and other arterial grafts are used frequently in coronary artery bypass grafting, the greater saphenous vein (GSV) is still the most often used conduit in the operation. Traditional open harvest technique carries a morbidity rate ranging from 1% to 24% (Delaria *et al*., 1981; Utley *et al*., 1989). The high morbidity rate stimulated the development of minimally invasive vein harvest procedures in the early 1990s (Lumsden *et al*., 1996). A small incision, less wound pain, and fewer complications were expected. This study evaluates the outcomes of an endoscopic technique and the traditional open method on postoperative wound complications and long-term graft patency.

‡ Corresponding author

## PATIENTS AND METHODS

Between January 2004 and December 2005, a total of 392 patients underwent off-pump coronary artery bypass grafting at National Taiwan University Hospital. Those with pre-operative intra-aortic balloon pump application and varicose GSVs (total 44 patients) were excluded from the study. Among the remaining 348 patients, 78 had their GSVs harvested by the traditional open vein harvest (OVH) method, and the other 270 by the endoscopic vein harvest (EVH) method. These included 281 males and 67 females with the ratio of 4.2, and the mean age was (63.75±10.40) years (Table 1).

The clinic characteristics including body mass index, presence of diabetes mellitus, peripheral vascular diseases, steroid use, left ventricular ejection fraction, renal function, and angina character are presented in Table 1, and the preoperative baseline laboratory data in Table 2. Intraoperative findings including total operation time, percentages of left internal mammary artery (IMA) anastomosis to left anterior descending artery, numbers of GSV injuries, and mean bypass numbers of vein graft are listed in Table 3. Postoperative data including hospitalization days, wound condition, and coronary events are shown in Tables 3~4. ASEPSIS score was applied to measure the wound condition during hospitalization (Wilson *et al*., 1990). Visual analog scale (VAS) was used for pain degree assessment. The sensitivity of this test has been validated (McGuire, 1984; Graceley, 1986). The scale consisted of a 10-cm horizontal line with a score of 0 representing no pain at all and a score of 10 representing the worst pain ever experienced. The pain scale was analyzed based on the record on postoperative Day 3.

Statistical analysis was performed with the StatsDirect statistical software version 2.5.7 for Windows XP. Categorical variables were compared by chi-square test or Fisher's exact test, where appropriate. Ordinary variables were compared by unpaired Student's *t*-test. Data are expressed as mean± standard deviation. The result is statistically significant when *P*-value is less than 0.05.

## RESULTS

Table 3 shows the intraoperative data including total operation time, percentage of IMA use, GSV injury, and mean number of vein bypass grafts. The mean vein bypass number in the EVH group was 3.2±0.7, significantly greater than 2.8±0.7 in the OVH group (*P*=0.0002). Mean days of hospital stay was comparable between two groups, (13.2±3.3) d for the OVH group and (12.8±3.1) d for the EVH group (*P*=0.6374, Table 3). There were 6 (2.22%, 6/270) patients in the EVH group converted to an open approach due to a technical failure in 3, poor vein quality in 2, and $CO_2$ embolism in 1.

The two groups differed significantly in the incidence of postoperative wound conditions including wound infection rate, pain scale, and hematoma complications (Table 4). The total wound complication rates were 19.2% in the OVH group and 5.2% in the EVH group (*P*=0.0002). The wound conditions two months after the operation were still significant higher in the OVH group (14.1%) than in the EVH group (5.9%) (*P*=0.0326, Table 5).

The rates of graft failure defined by the clinical evidence for myocardial infarction during the first year's follow-up were low in both groups (Table 6). There were 4 mortality cases in the EVH group, 2 resulting from multiple organ failure, 1 due to septic shock, and 1 hepatocellular carcinoma. It is worth noting that no deaths were related to leg wound complications (Table 7).

**Table 1 Patients' characteristics**

| Group | Patient number | Gender, M/F | Age (year) | Body mass index (kg/m$^2$) | Diabetes | PAOD | Steroid use | LVEF (%) | Dialysis use | Unstable angina |
|---|---|---|---|---|---|---|---|---|---|---|
| OVH | 78 | 55/23 | 63±7* | 25.5±2.8 | 33 (42%)** | 2 (2.6%) | 1 (1.3%) | 56±11 | 2 (2.6%) | 50 (64%) |
| EVH | 270 | 226/44 | 64±9 | 25.4±2.5 | 101 (37%) | 7 (2.6%) | 2 (0.7%) | 59±9 | 10 (3.7%) | 133 (49%) |
| *P* value | | | 0.9589 | 0.3861 | 0.5148 | >0.9999 | 0.5341 | 0.0441 | >0.9999 | 0.029 |

OVH: open vein harvest; EVH: endoscopic vein harvest; PAOD: peripheral arterial occlusive disease; LVEF: left ventricular ejection fraction. *mean±SD; ***n* (%)

**Table 2 Preoperative baseline laboratory data**

| Group | Creatinine (mg/dl) | Hemoglobin (g/dl) | Hematocrit (%) | Uric acid (mg/dl) | White blood cell count (×10$^3$/μl) | Cholesterol (mg/dl) | Low-density lipoprotein (mg/dl) | Albumin (g/dl) |
|---|---|---|---|---|---|---|---|---|
| OVH | 1.35±0.44 | 14.0±3.6 | 37.2±4.7 | 6.66±1.85 | 7472±1830 | 207±35 | 109±32 | 4.0±0.4 |
| EVH | 1.44±0.60 | 12.7±1.5 | 38.7±4.5 | 6.54±1.48 | 7335±1863 | 199±40 | 111±32 | 4.2±0.4 |
| *P* value | 0.5848 | 0.4434 | 0.0643 | 0.6315 | 0.5207 | 0.6283 | 0.7301 | 0.0196 |

OVH: open vein harvest; EVH: endoscopic vein harvest. All data except *P* values are expressed as mean±SD

**Table 3 Intraoperative data and length of hospital stay**

| Group | Total operation time (min) | IMA use | GSV injury | Number of vein bypass | Hospital stay (d) |
|---|---|---|---|---|---|
| OVH | 262±45 | 72 (92.3%) | 3 (3.9%) | 2.8±0.7 | 13.2±3.3 |
| EVH | 278±55 | 247 (91.5%) | 1 (0.4%) | 3.2±0.7 | 12.8±3.1 |
| *P* value | 0.1617 | >0.9999 | 0.0731 | 0.0002 | 0.6379 |

OVH: open vein harvest; EVH: endoscopic vein harvest; IMA: internal mammary artery; GSV: greater saphenous vein. All data except *P* values are expressed as mean±SD or *n* (%)

**Table 4 Postoperative wound condition**

| Group | ASEPSIS score | Infection (pus) | Pain scale | Hematoma | Dehiscence | Drainage | Edema | Altered sensation | Debridement | Mobility | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| OVH | 1.1±1.7 | 4 (5.1%) | 2.9±0.7 | 3 (3.8%) | 1 (1.3%) | 1 (1.3%) | 1 (1.3%) | 2 (2.6%) | 3 (3.8%) | 0 | 15 (19.2%) |
| EVH | 0.9±1.5 | 4 (1.5%) | 2.5±1.2 | 1 (0.4%) | 2 (0.7%) | 1 (0.4%) | 2 (0.7%) | 1 (0.4%) | 3 (1.1%) | 0 | 14 (5.2%) |
| *P* value | 0.6125 | 0.0474 | 0.0275 | 0.0366 | 0.5341 | 0.3985 | 0.5341 | 0.1274 | 0.1289 | | 0.0002 |

OVH: open vein harvest; EVH: endoscopic vein harvest. All data except *P* values are expressed as mean±SD or *n* (%)

**Table 5 Wound condition two months after the operation**

| Group | Infection (pus) | Pain scale | Dehiscence | Hematoma | Drainage | Edema | Altered sensation | Debridement | Mobility | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| OVH | 2 (2.6%) | 0.11±0.20 | 1 (1.3%) | 0 | 0 | 6 (7.7%) | 1 (1.3%) | 1 (1.3%) | 0 | 11 (14.1%) |
| EVH | 4 (1.5%) | 0.07±0.14 | 0 | 1 (0.4%) | 0 | 9 (3.3%) | 1 (0.4%) | 0 | 1 (0.4%) | 16 (5.9%) |
| *P* value | 0.6196 | 0.6217 | 0.2241 | >0.9999 | | 0.113 | 0.3985 | 0.2241 | >0.9999 | 0.0326 |

OVH: open vein harvest; EVH: endoscopic vein harvest. All data except *P* values are expressed as mean±SD or *n* (%)

**Table 6 Graft failure (myocardial infarction) during the first postoperative year**

| Group | Acute graft failure (perioperative MI) | Late graft failure during one-year follow up |
|---|---|---|
| OVH | 1 (1.3%) | 1 (1.3%) |
| EVH | 1 (0.4%) | 3 (1.1%) |
| *P* value | 0.3985 | 0.9999 |

OVH: open vein harvest; EVH: endoscopic vein harvest. All data except *P* values are expressed as *n* (%)

**Table 7 Moraloty after operation**

| Group | No. | Time (post operative days) | Cause |
|---|---|---|---|
| OVH | 0 | | |
| EVH | 4 (1.5%)* | 11 months | Multiple organ failure |
| | | 3 months | Sepsis shock, aspiration pneumonia |
| | | 13 months | Multiple organ failure |
| | | 22 months | Hepatocellular carcinoma |

OVH: open vein harvest; EVH: endoscopic vein harvest. * *n* (%)

## DISCUSSION

EVH was reported to be associated with less wound complications and less pain in previous studies (Allen *et al*., 1998; Marty *et al*., 2000). Allen *et al*.(1998) reported a wound complication rate of 4% in the EVH group and 19% in the OVH group, which is similar to our observations (5.2% for EVH and 19.2% for OVH). In the current study, we used ASEPSIS score to estimate the wound healing status, based on Bonde *et al*.(2004)'s study. Although the average score was not statistically different between the two groups, several individual parameters, such as percentage of total wound complications, presence of wound pus accumulation, presence of hematoma, and leg pain measured by the visual analog scale, were significantly lower in the EVH group than in the OVH group. This indicates that the lower occurrence of wound complication and the lower pain degree were due to the effectiveness of the EVH technique. The small incision and less invasive approach in the EVH procedure were the keys leading to better cosmetic results and patient satisfaction.

The conversion rate in our study was 2.22%, which is quite low compared to others (Allen *et al*., 1998). In our study, the causes of conversion include technical failure in 3 cases, poor vein quality in 2, and $CO_2$ embolism in 1. For technical factors, a learning curve of 20 to 30 cases was required for a technician or a junior resident to master this sophisticated technique (Bonde *et al*., 2004). During the operation, a patience of an attending surgeon, who is managing IMA and harvesting the vain at the same time, is necessary for a smooth and safe vein harvesting course. For vein quality management, we suggest an application of preoperative vascular ultrasound for every patient, for the varicosity of GSV can be easily detected preoperatively. Furthermore, delineating a mark right above the vein not only shortens the time for locating the vein and decreases the chance of vein injury, but also improves wound status. For $CO_2$ embolism, an insufflation pressure of 12 mmHg was believed to be associated with a reduced incidence (Chiu *et al*., 2006). In our experience, the insufflation pressure was around 15 to 18 mmHg. Although only one case of $CO_2$ embolism occurred in the present study, it might be due to the negligence of monitoring an early sign occurring until a significant hemodynamic change drew our attention. From our clinical observations, we speculated that a slight elevation of pulmonary artery pressure may represent an early sign of possible $CO_2$ embolism. Further prospective studies are necessary to examine the relationship between pulmonary artery pressure and incidence of $CO_2$ embolism.

To our knowledge, this is the first study comparing long-term graft patency rates between EVH and OVH methods for clinical evidence of myocardial infarction. Several studies have investigated acute graft closure or perioperative myocardial infarction. However, there was no apparent difference between the two techniques (Kiaii *et al*., 2002). In the current study, 4 late mortality cases occurred in the EVH group during follow-up. The causes were not directly related to the EVH procedure. Among the 4, 2 were with an end-stage renal failure and died from multi-organ failure 11 and 13 months post operation, respectively, 1 died from sepsis caused by aspiration pneumonia 3 months post operation, and 1 died from hepatocellular carcinoma 22 months post operation. Neither early nor late myocardial infarction rate was found significantly different between the two groups. This suggests that the endoscopic vein harvest technique has a similar impact on venous endothelium to the open technique. However, a ‘no-touch’ principle is still pivotal in any harvest techniques and cannot be overlooked.

Most reported endoscopic harvest techniques involved 2 or more incisions. The incisions were required for proximal and distal vein ligation and division. We have modified the technique to reduce 2 incision sites to only 1 distal site. As usual, the distal incision was created for dissecting a cannula insertion (VasoView system, Guidant Cardiac and Vascular Surgery, Menlo Park, CA, USA). The proximal incision was replaced by a No. 1 Silk suture, which was used for vein ligation by looping around the proximal GSV percutaneously. Safety and completeness of the procedures could be checked on a TV screen (Luh and Liu, 2006). After securing with surgical tie, the vein was ligated and divided with a bipolar scissor. The knot was removed 3 d after the operation.

Lastly, we believe that, although this study is restricted by its retrospective nature and decision about performing either EVH or OVH depends on individual surgeon’s preference, the result still reflects a certain degree of reality in clinic (Lopes *et al*., 2009).

## CONCLUSION

EVH technique is a reliable and promising method in the greater saphenous vein harvest procedure. It is associated with improved outcome and better patient satisfaction in wound conditions and pain scale. Meanwhile, EVH does not compromise the early or late graft patency rate when compared to the traditional open technique. We believe it will become a standard procedure for the elective off-pump coronary artery bypass grafting in the future.

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